APEX experiment beamline considerations

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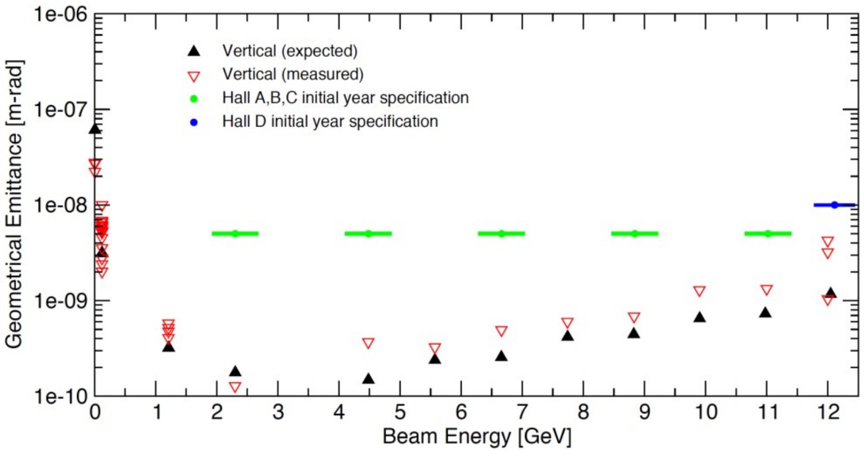
Overview

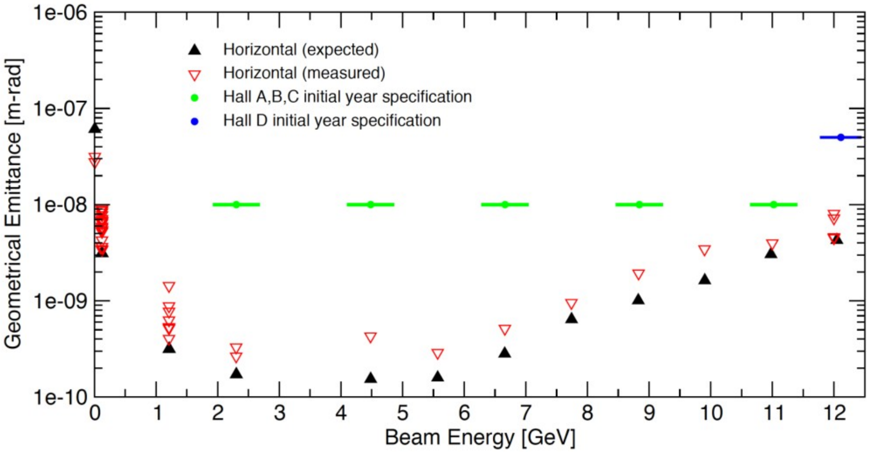
- Experimental requirements
- Machine overview
- HALL A beamline layout and optics
- Commissioning the beamline
  - Raster
  - Current monitors
  - Wire scanners and bpms
  - Septum magnet
  - Orbit stabilization
- Reaching high current

Experimental requirements

- Beam conditions:
  - Up to 120 μAmps at 1.1, 2.2, 3.3 and 4.4 GeV
  - Rasterized beam (full size) 0.5 mm x 5.0 mm on target
  - Beam stability <200 μm X&Y
  - Beam size <200 μm X & Y

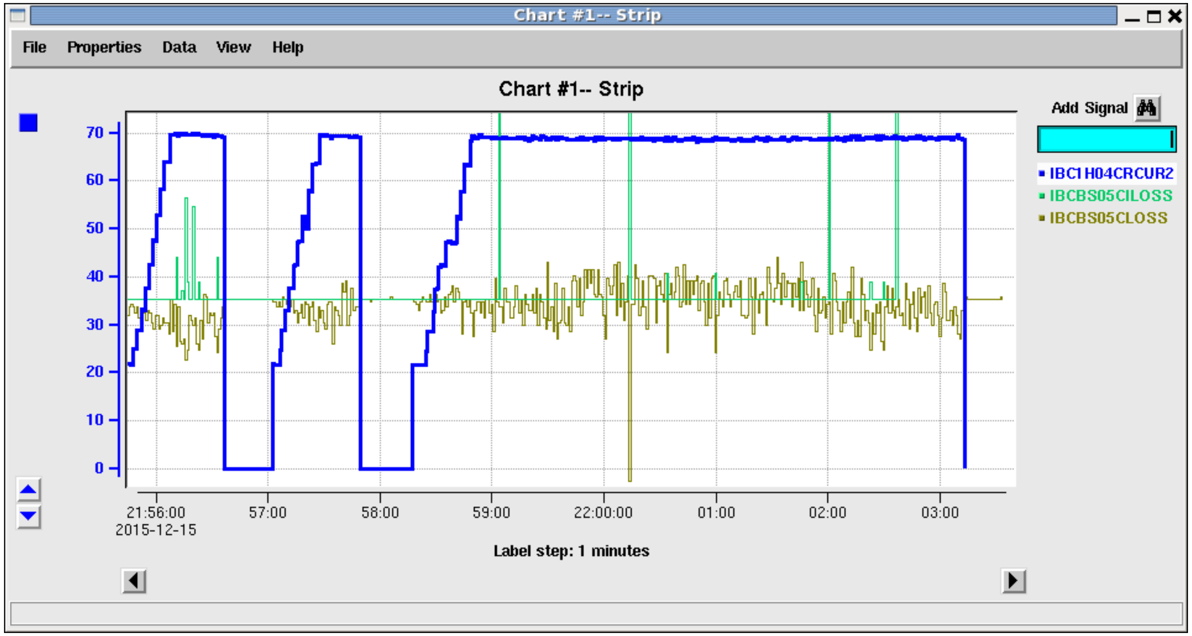
Main machine setup





- 12 GeV machine meet specifications for physics
- Procedures vastly improved over 6GeV to allow for a reproducible setup close to design

HALL A to 70 µA CW at 11GeV

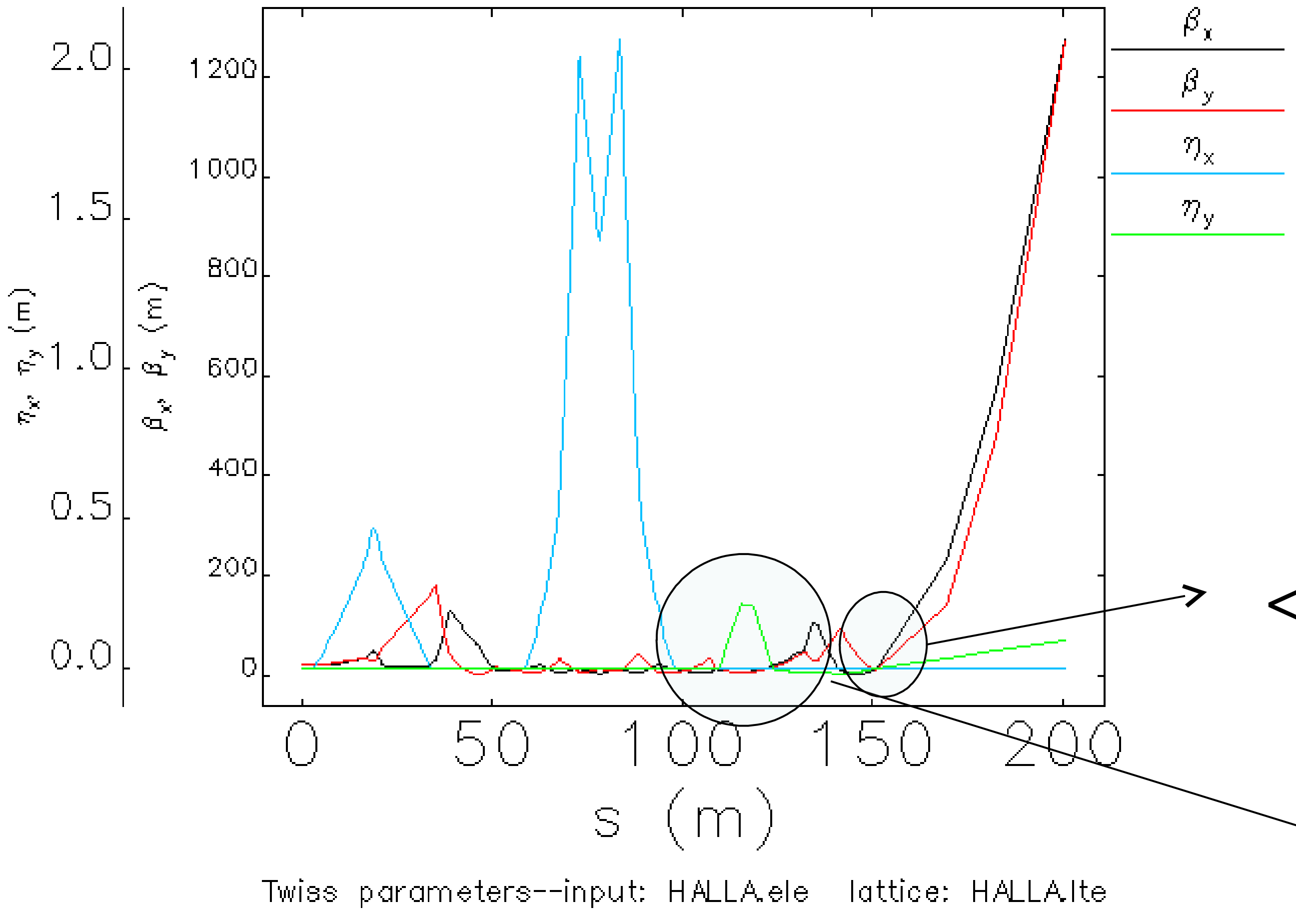


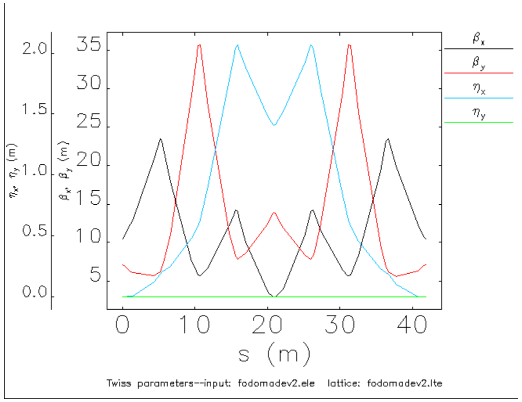
70x11=770 kW of CW beam (dump limit).

At 4.4 GeV we can support:
4.4*120=480 kW

New HALL A optics

Low emittance growth, Low beta. **We reached 800 kW with it.**

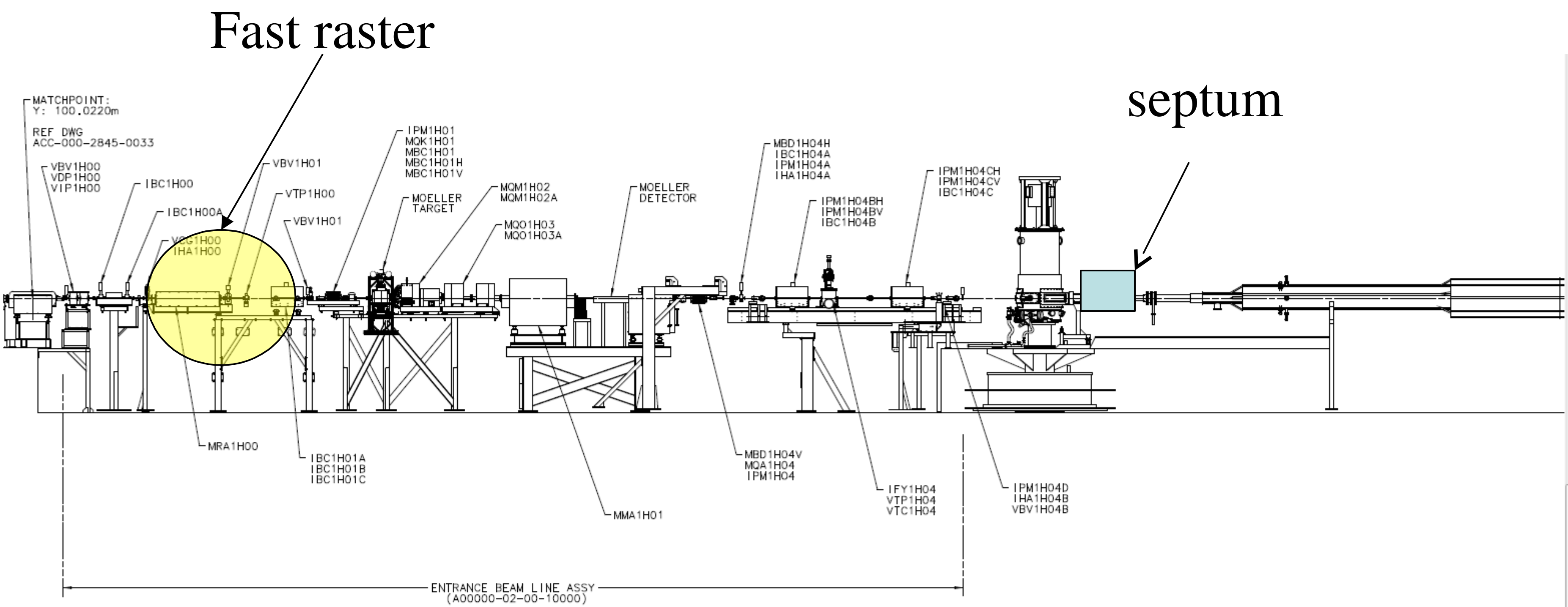




<200 μm at target

Compton 110x70μm

HALL A beamline



Shown from the end of Compton polarimeter towards dump.

We will go straight-thru Compton for this experiment.

Raster commissioning

Four coils. Two X and two Y.

Max capacity of 50 Amps/coil.
Which is approximately 4300 G.cm/coil

1. Check wiring and polarities
2. Check power supplies
3. Validate with beam

Raster checks(cont)-verify-polarity

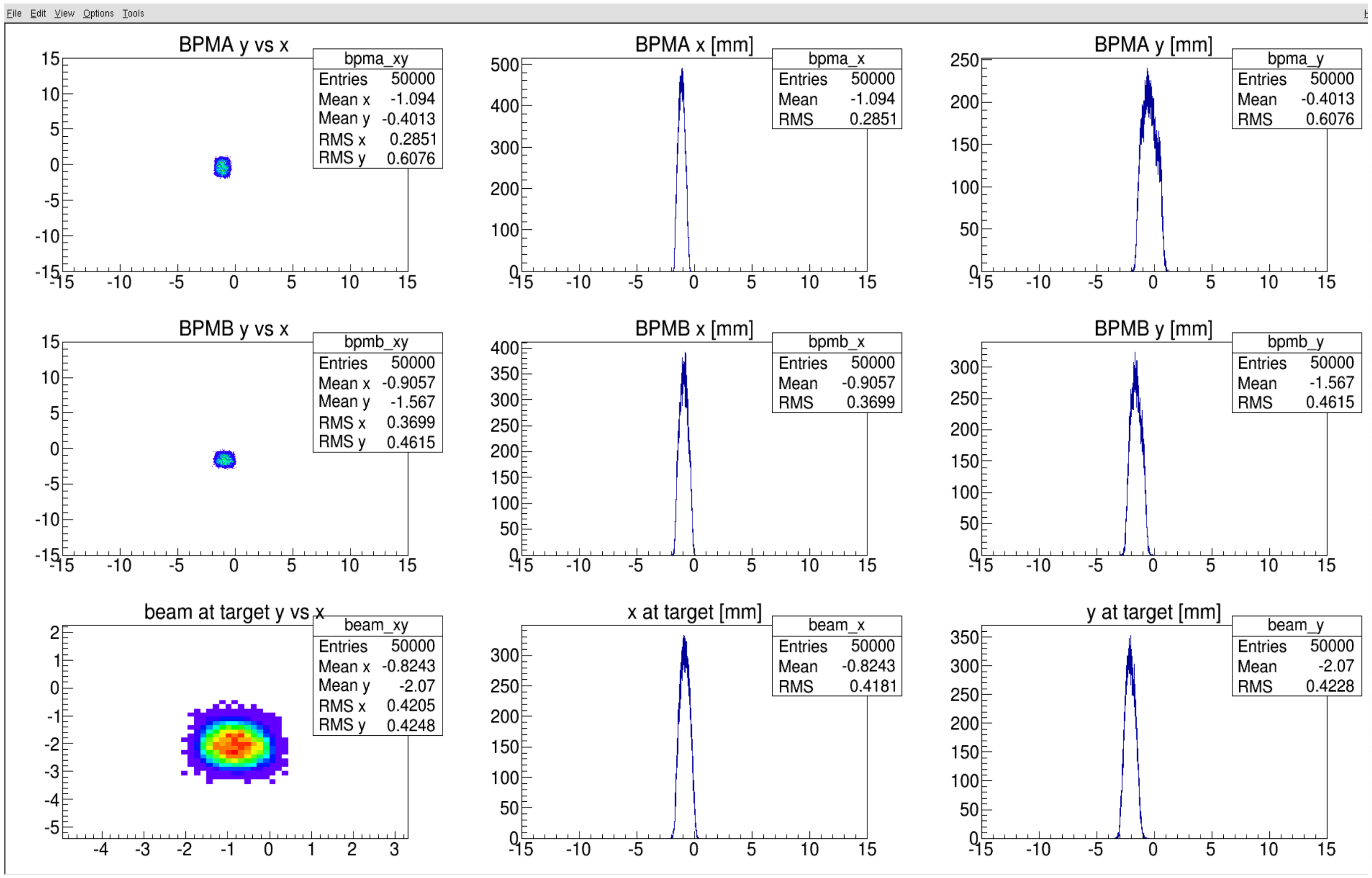
- Small pickup coils were added next to the big coils in order
  to check whether or not the coils are in phase or out of phase. This will cover us from:

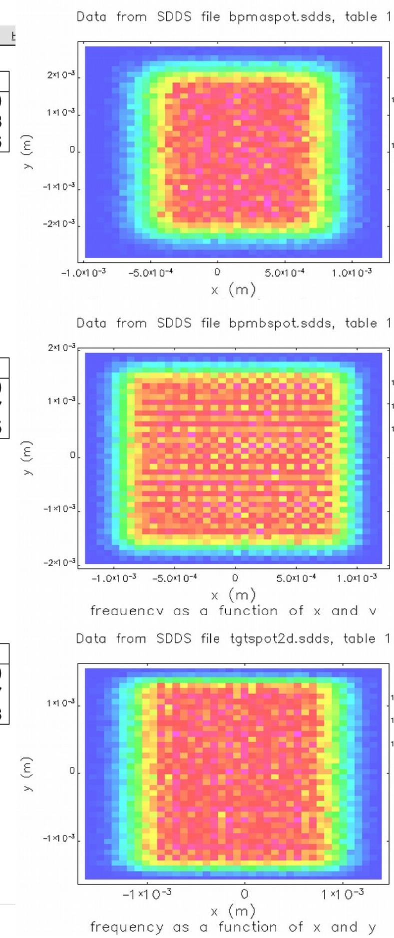
- We found an instance of mis-cabled coils (two Y coils canceling each other)

- We found an instance of a power supply with reverse polarity (yielding coils canceling each other even thought cabling was correct..)

- The procedure was strengthened to provide us with certainty that the hardware is functional before sending beam

Raster checks with beam

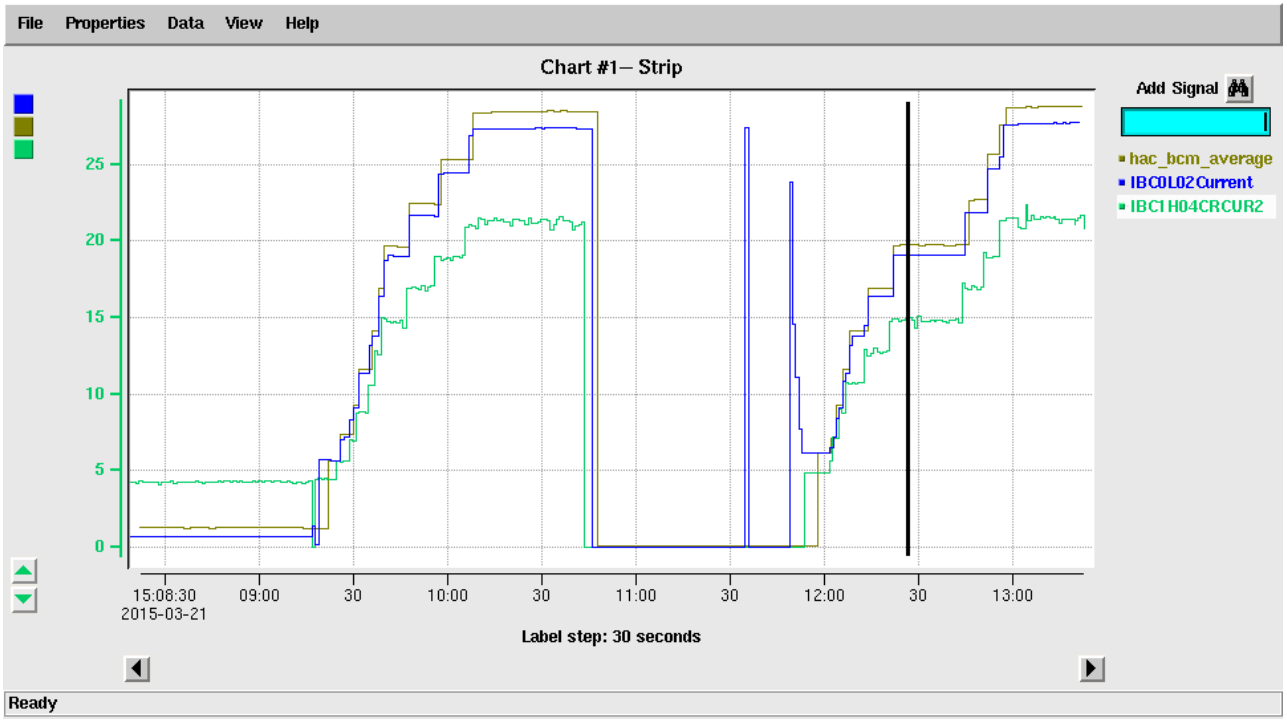




This is for a 2mmx2mm raster. Optics model can predict raster size.

Current monitors

- Need to perform BCM calibrations (we have standard procs)
  - 1) establish CW beam to HALL A with no loss.
  - 2) perform Unser versus BCM calibration
  - 3) perform Injector BCM versus Hall A BCM calibration



Beam position monitors

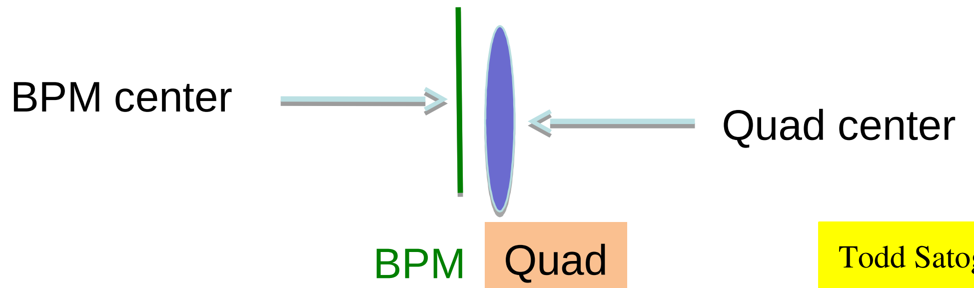
Essentially a RF pick up system providing Beam position.

1. Functional testing
2. Relative calibration of antennas
3. Alignment of BPM relative to quads

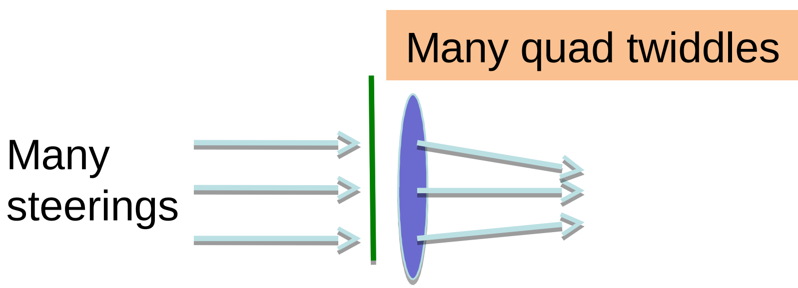
2) Is done without beam during the hot checkout by injecting an analog signal
1) and 3) are done with beam.

Centering bpm cans to quadrupoles

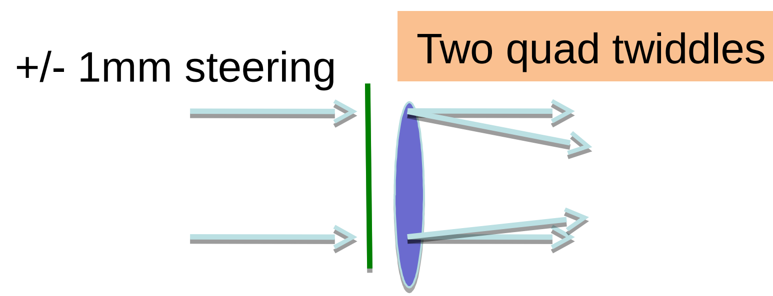
- **AutoQuad**: new algorithm to set BPM SOF so steering to zero on BPM is steering though center of nearby quad
  - SOF = “survey offset” (including electrical offset)
  - ~5 minutes per quad (see TN-14-027 for algorithm details)



Todd Satogata

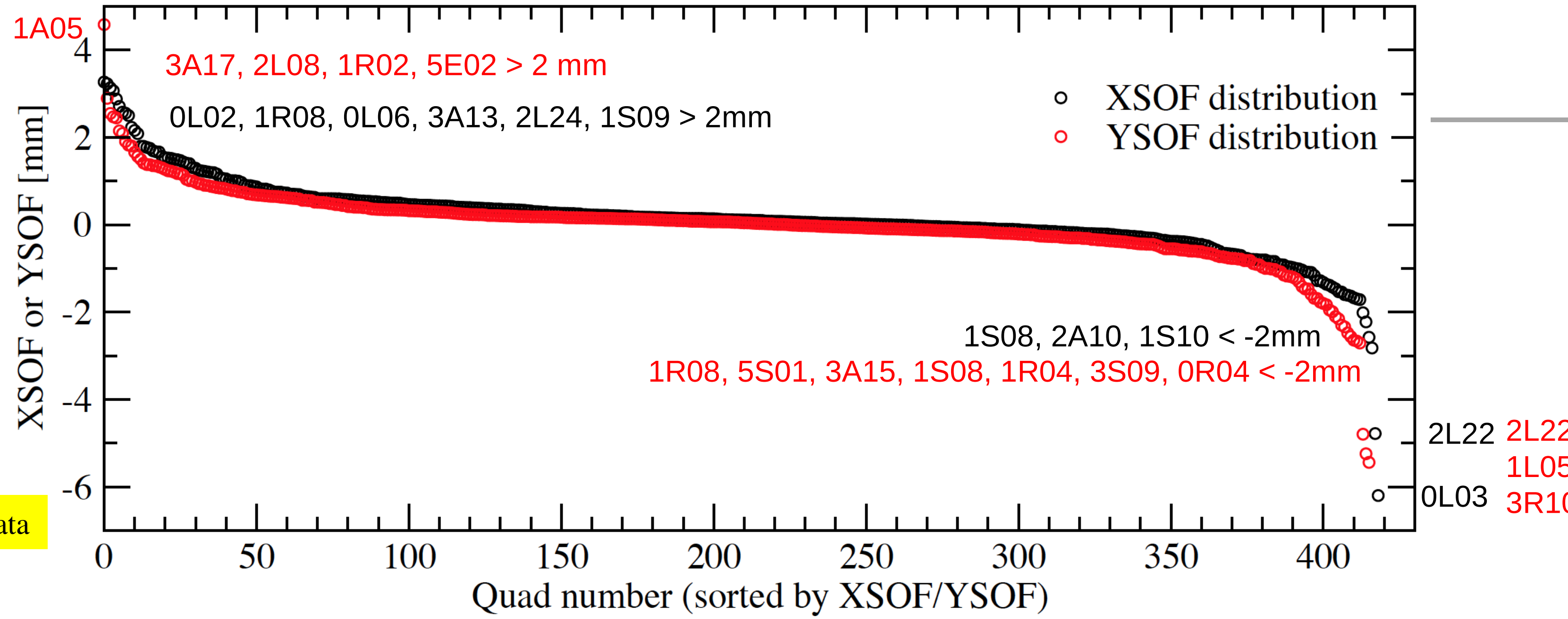


Old Algorithm: Find steering that nulls downstream orbit changes when quad twiddling



New Algorithm: Find center from asymmetric orbit response of two symmetric twiddles

AutoQuad XSOF/YSOF distribution: Wed Dec 2 2015 (into 5S)



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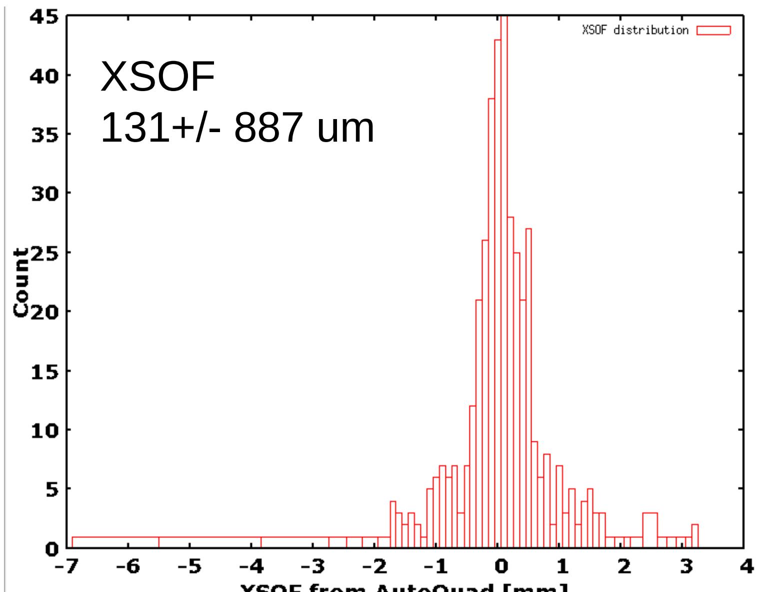
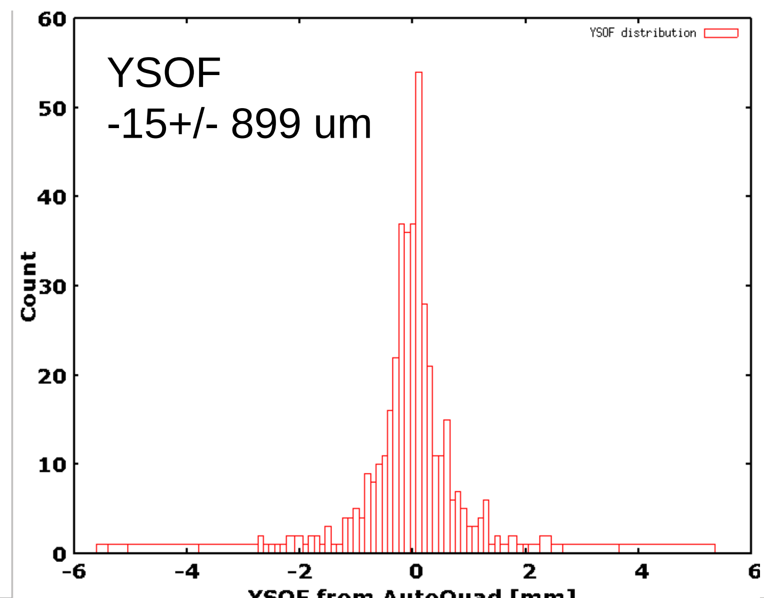
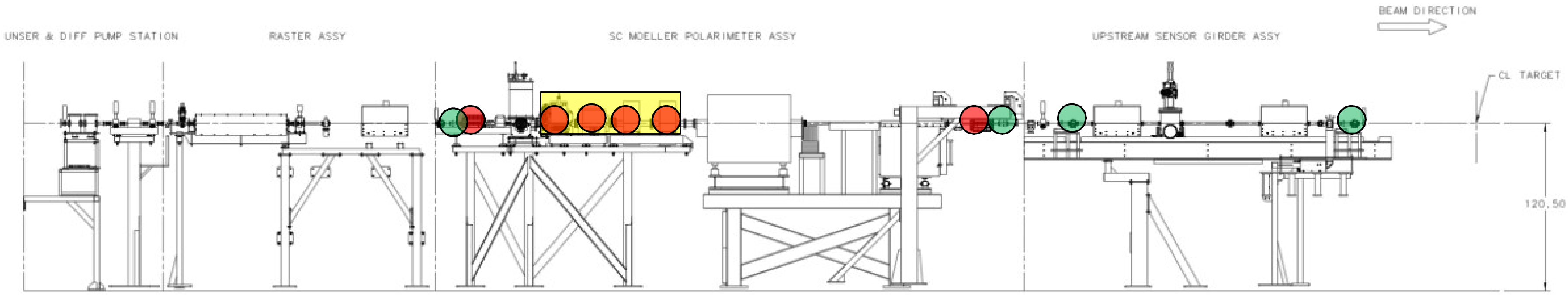




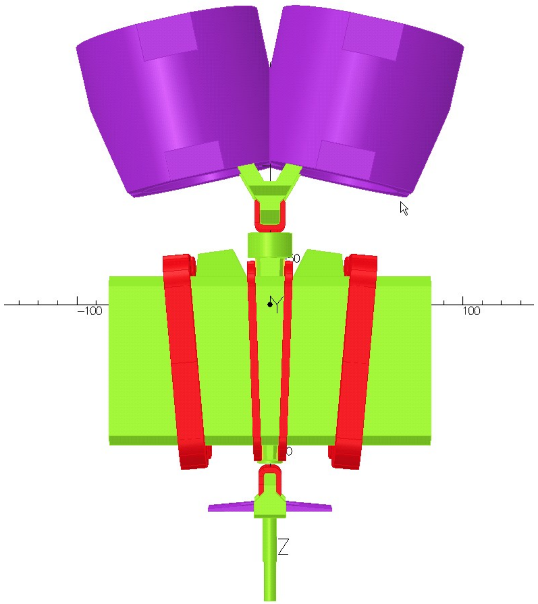
Aligning diagnostic girder bpms

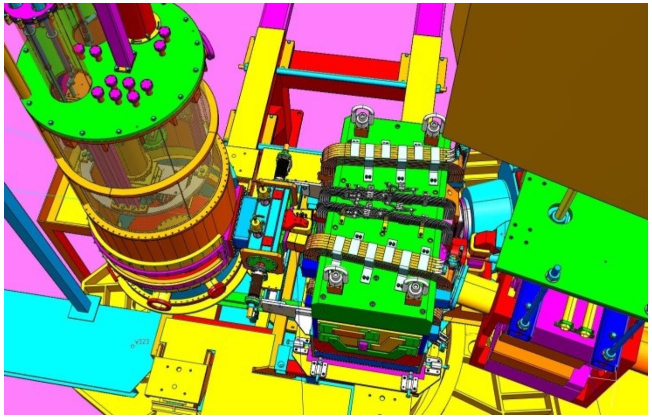


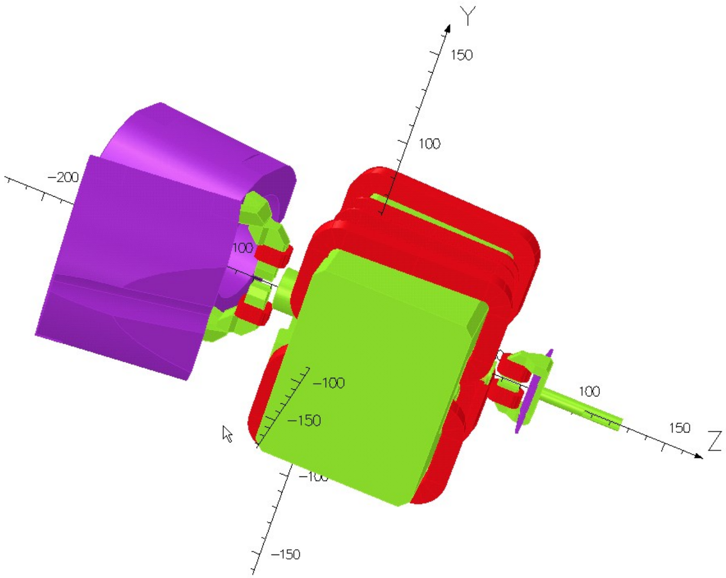
- Bpms (green circle)
- Quadrupoles (red circle)
- Moeller Quadrupoles (yellow box)

1. Align bpm with 1C20 and 1H01 quads
2. Align 1H04 bpm with 1H04 quad
3. Turn off 1H04 quad
4. Turn off Moeller quadrupoles.
5. Send beam at zero on 1H01/1H04
6. Read off 1H04A/1H04E, this is the offset

Septum magnet

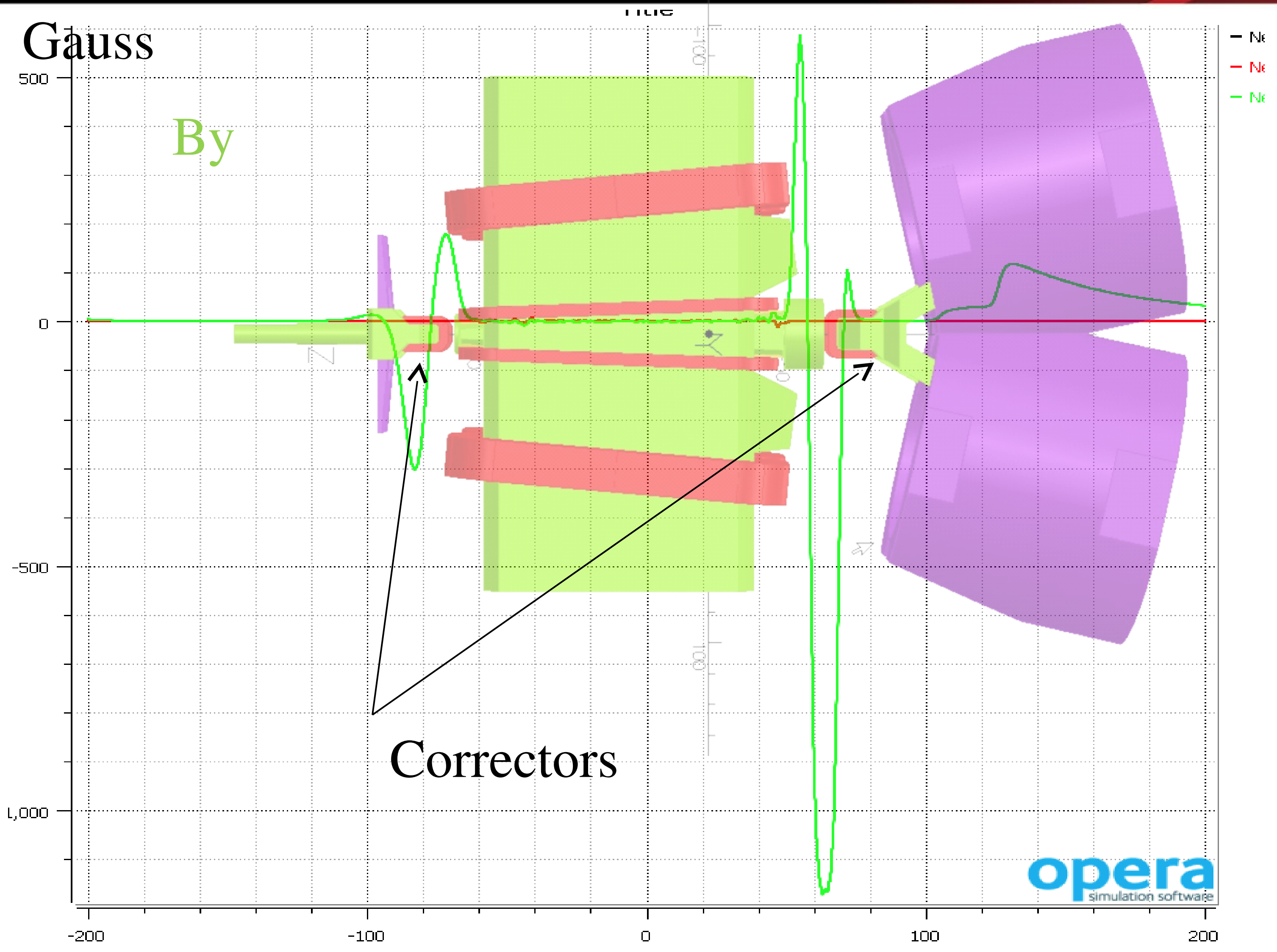






TOSCA simulations provided a 3D field which we used to validate the design by tracking.

TOSCA calculations for beam on axis



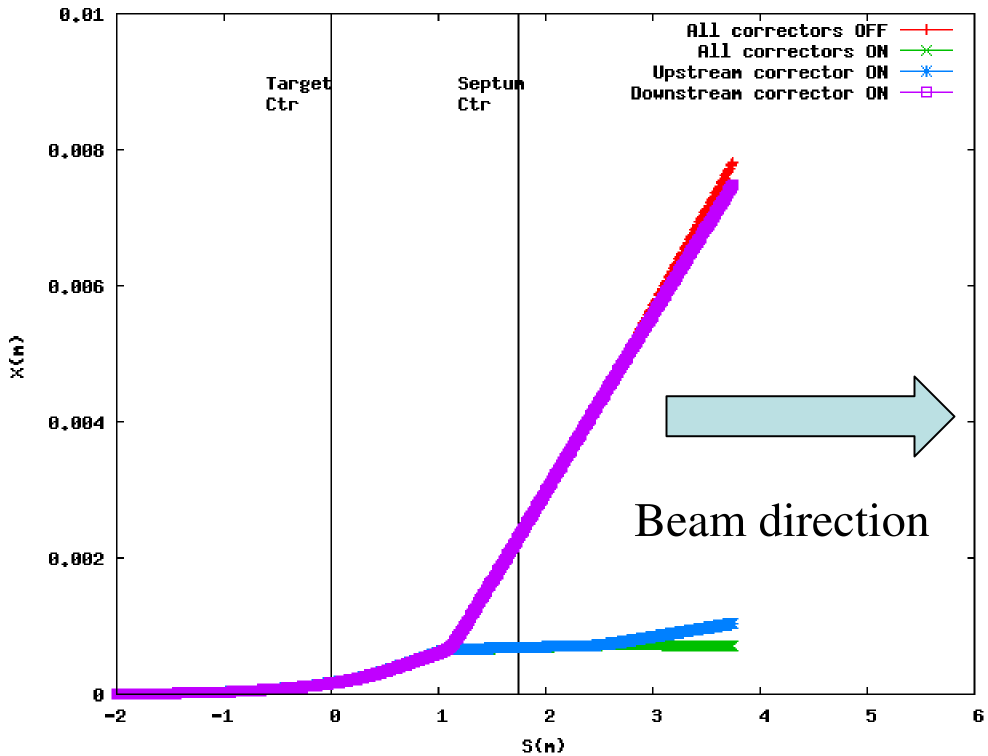
MAP with 8M elements

+/- 2 cm in X/Y

-4m/+2m in Z

Stepsize 2mm X,Y and Z

Tracking validation (in ELEGANT)

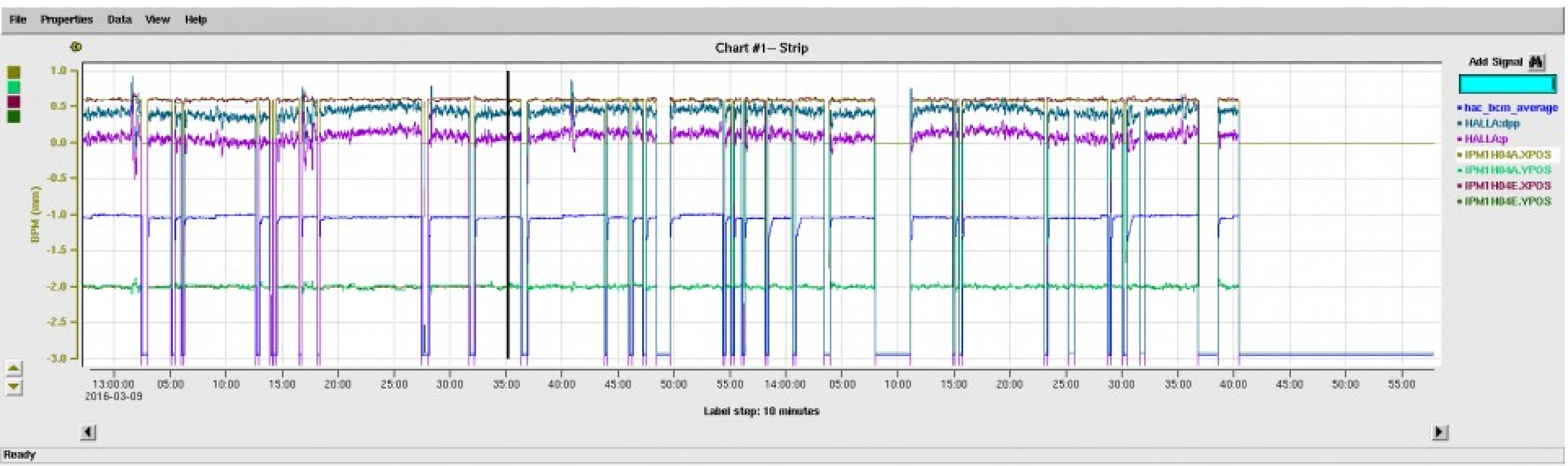


Main beam will exit with 0.7 mm offset in X and small angle. Will land exactly at center of dump.

Septum Field well compensated with the use of septum correctors.

Orbit stabilization

- Fast feedback system in energy mode commissioned at 4.483 GeV/c will stabilize energy and position fluctuations
- Slow target lock allows for centroid positioning



Beam very stable with locks engaged.

Commissioning with beam

1. Establish tune beam with raster off, septum off
2. Perform bpm/quad alignments
3. Perform girder alignment
4. Commission/check raster in tune mode
5. Find target center using usual methods, set position locks
6. Ramp up septum, set both correctors at design setpoint
7. Using IDW10D00 tune mode dump viewer locate beam
8. Adjust correctors if necessary
9. Engage FSD window comparator around correctors
10. Turn off a corrector, check that FSD trips beam.

Conclusion

- The beamline configuration is ready for APEX:

1. The Septum magnet design compensates leakage fields very well
2. Procedures developed for girder alignment
3. Feed back and lock systems commissioned
4. High current runs previously demonstrated
5. Raster system commissioned.